Illinois Department of Transportation

Memorandum

To:	ALL BRIDGE DESIGNERS	03.5
From:	Ralph E. Anderson	Ralph E. Anderson
Subject:	LRFD – Simplified Live Load Distribution	
Date:	October 1, 2003	

This memorandum is the third in a series detailing the Department's policies and procedures for implementation of the AASHTO LRFD Bridge Design Specification by October 1, 2007.

This bureau has simplified or eliminated several aspects of the procedures outlined in Chapter 4 of the LRFD Specifications for calculating live load distribution factors for both shear and moment. These procedures apply only to typical multi-beam bridge structures defined in ABD Memorandum 02.3.

The equations for calculating multi-lane and single-lane live load distribution factors for moment in concrete deck-on-steel girder and concrete deck-on-prestressed concrete girder bridges have been streamlined. The equations for interior beams were derived from Section 4.6.2.2 of the LRFD specifications and are given below for multi- and single-lane factors, respectively. Exterior beam overhang lengths should be within the boundaries outlined in ABD Memo 02.3.

$$0.075 + C \times \left(\frac{S}{9.5}\right)^{0.6} \left(\frac{S}{L}\right)^{0.2} \quad \text{Multi - Lanes Loaded}$$

$$0.06 + C \times \left(\frac{S}{14}\right)^{0.4} \left(\frac{S}{L}\right)^{0.3} \quad \text{Single - Lane Loaded}$$

Where :

$C =$ 1.02 for steel beams,
1.10 for prestressed I - beams (36", 42", 48", 54") and
1.15 for prestressed bulb tee - beams (63", 72")

$S =$ Beam Spacing in feet

$L =$ Span length in feet

The C coefficient replaces the following term in LRFD formulae which is a measure of the ratio of the longitudinal to transverse superstructure stiffness.

$$\left(\frac{K_g}{12.0 \times L \times t_s^3} \right)^{0.1}$$

Where:

t_s = *Slab* thickness in inches

K_g = Longitudinal stiffness parameter

$= n\left(I + Ae_g^2\right)$

n = *Modular ratio*

I = Beam moment of inertia in inches^4

A = *Cross* sectional *beam area* in inches^2

e_g = Distance from the centroid of the beam to the centroid of the slab in inches

The simplified equations eliminate the potential iterative aspect of calculating design moments in LRFD. The multi-lane loading shall be used for nominal strength design and the single-lane loading shall be used for fatigue and stud shear connector design. Extensive research was conducted by IDOT to validate the revised equations. Design aids for multi-lane distribution factors are given in Figures 1 to 3 for steel and prestressed concrete girders with typical Illinois beam spacings and span lengths.

The reduction of load distribution factors for moment in primary girders stipulated in Table 4.6.2.2.2e-1 for skewed bridges shall not be applied with typical Illinois bridges.

Section 4.6.2.2.2d and reference to it in Section 4.6.2.2.3b of the LRFD specifications shall also not be applied with typical Illinois bridges. The article specifies unrealistic moment and shear distribution factors for exterior beams in bridges with diaphragms or cross frames which have rigid connections to primary superstructure girders. Rigid frame-like behavior transversely across bridge decks is not the typical case for Illinois bridges.

The skew correction/amplification factor equation for the shear distribution factor prescribed in Table 4.6.2.2.3c-1 for concrete deck-on-steel or prestressed concrete girders shall be simplified to the formula given below for typical Illinois bridges.

$$1.0 + 0.20 \tan\theta$$

Where :

θ = Skew angle

The term which is a measure of transverse to longitudinal superstructure stiffness and given below was set equal to unity (1).

$$\left(\frac{12.0 \times L \times t_s^3}{K_g} \right)^{0.3}$$

In addition, the skew correction for shear shall only be applied at abutments. Piers are excluded. The skew correction factor is applicable to all beams.

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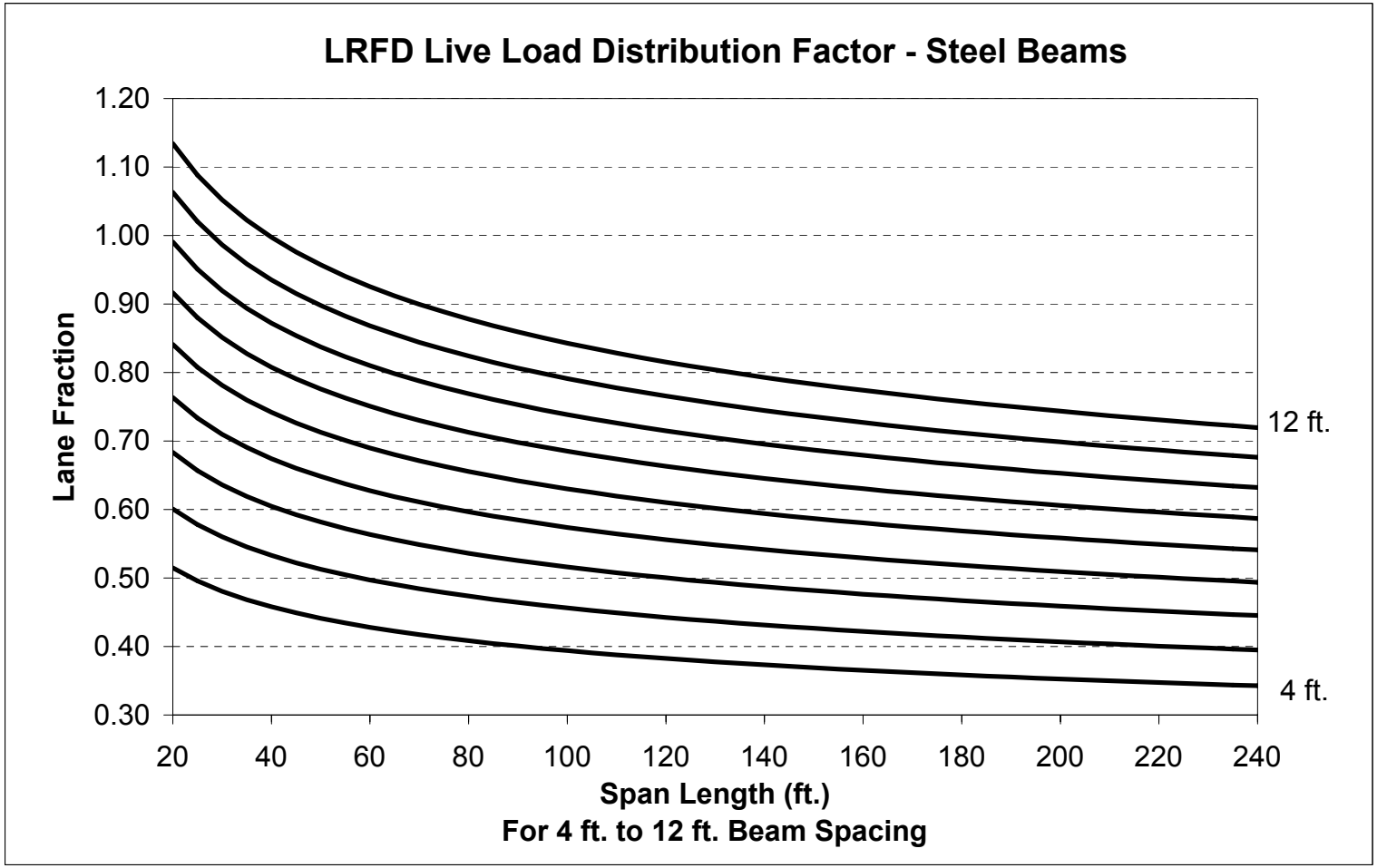
LRFD Live Load Distribution Factor - Steel Beams
Lane Fraction
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
20
40
60
80
100
120
140
160
180
200
220
240
Span Length (ft.)
For 4 ft. to 12 ft. Beam Spacing
12 ft.
4 ft.

Figure 1

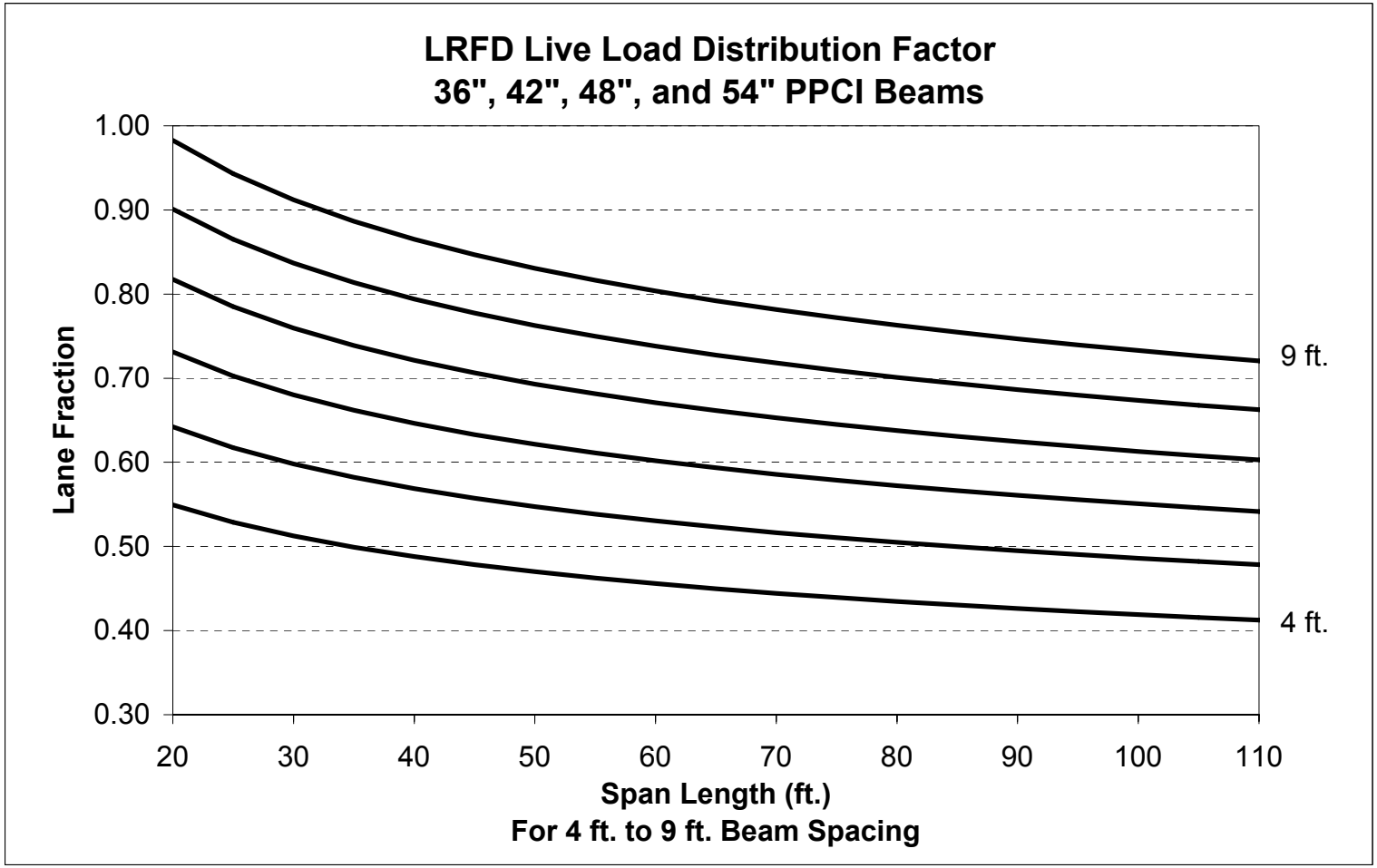
LRFD Live Load Distribution Factor
36", 42", 48", and 54" PPCI Beams
Lane Fraction
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
9 ft.
4 ft.
20
30
40
50
60
70
80
90
100
110
Span Length (ft.)
For 4 ft. to 9 ft. Beam Spacing

Figure 2

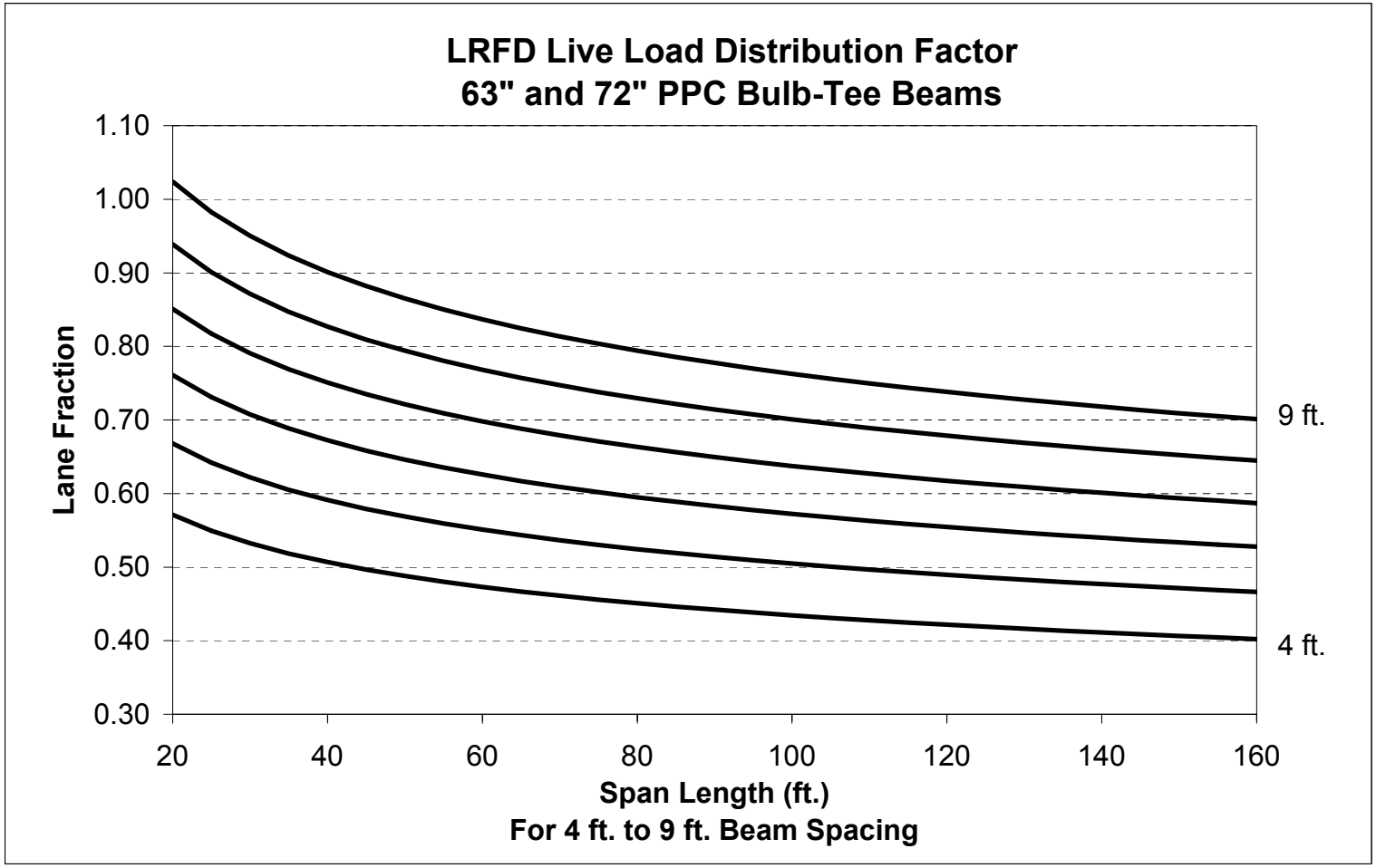
LRFD Live Load Distribution Factor
63" and 72" PPC Bulb-Tee Beams
Lane Fraction
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
20
40
60
80
100
120
140
160
9 ft.
4 ft.
Span Length (ft.)
For 4 ft. to 9 ft. Beam Spacing

Figure 3